

2018-09-27

North Devon Marine Pioneer, links between the ecosystem and ecosystem services in the North Devon Marine Pioneer

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<http://hdl.handle.net/10026.1/14926>

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Executive Summary

North Devon Marine Pioneer

Links between the ecosystem and ecosystem services in the North Devon Marine Pioneer



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Suggested citation for this report:

Rees, S.E., Ashley, M., Cameron, A. 2018. Executive Summary: North Devon Marine Pioneer, links between the ecosystem and ecosystem services in the North Devon Marine Pioneer. A report to WWF-UK by research staff the Marine Institute at University of Plymouth.

Acknowledgements:

This work was funded by WWF-UK and SWEEP. The authors would like to thank staff from the Devon and Severn IFCA, Natural England, Plymouth Marine Laboratory, North Devon Council and North Devon Biosphere for assistance with data and advice.

Introduction

Marine ecosystems provide a number of essential functions, such as primary production and climate regulation, which underpin life on earth (Millennium Ecosystem Assessment, 2005). These essential functions, in turn, deliver flows of ecosystem services that support human wellbeing from both a localised context e.g. food, flood protection, opportunities for recreation, and globally e.g. supporting a healthy, habitable climate.

To underpin these flows of services from the natural environment The UK Government's 2011 commitment to mainstream the value of nature across our society, to create a green economy and to strengthen the connections between people and nature has been realised in the Government's 2018 publication for a *25 Year Plan to Improve the Environment*. The 25 Year Plan incorporates the Natural Capital Committee's (NCC) recommendations to integrate an approach to improve natural capital in three parts: building blocks; investment and; financing. A Natural Capital Approach considers the relationship between natural assets (e.g. species, habitats, water, and air); the services they support (e.g. erosion protection, water purification) and the societal benefits obtained (e.g. food, recreation).

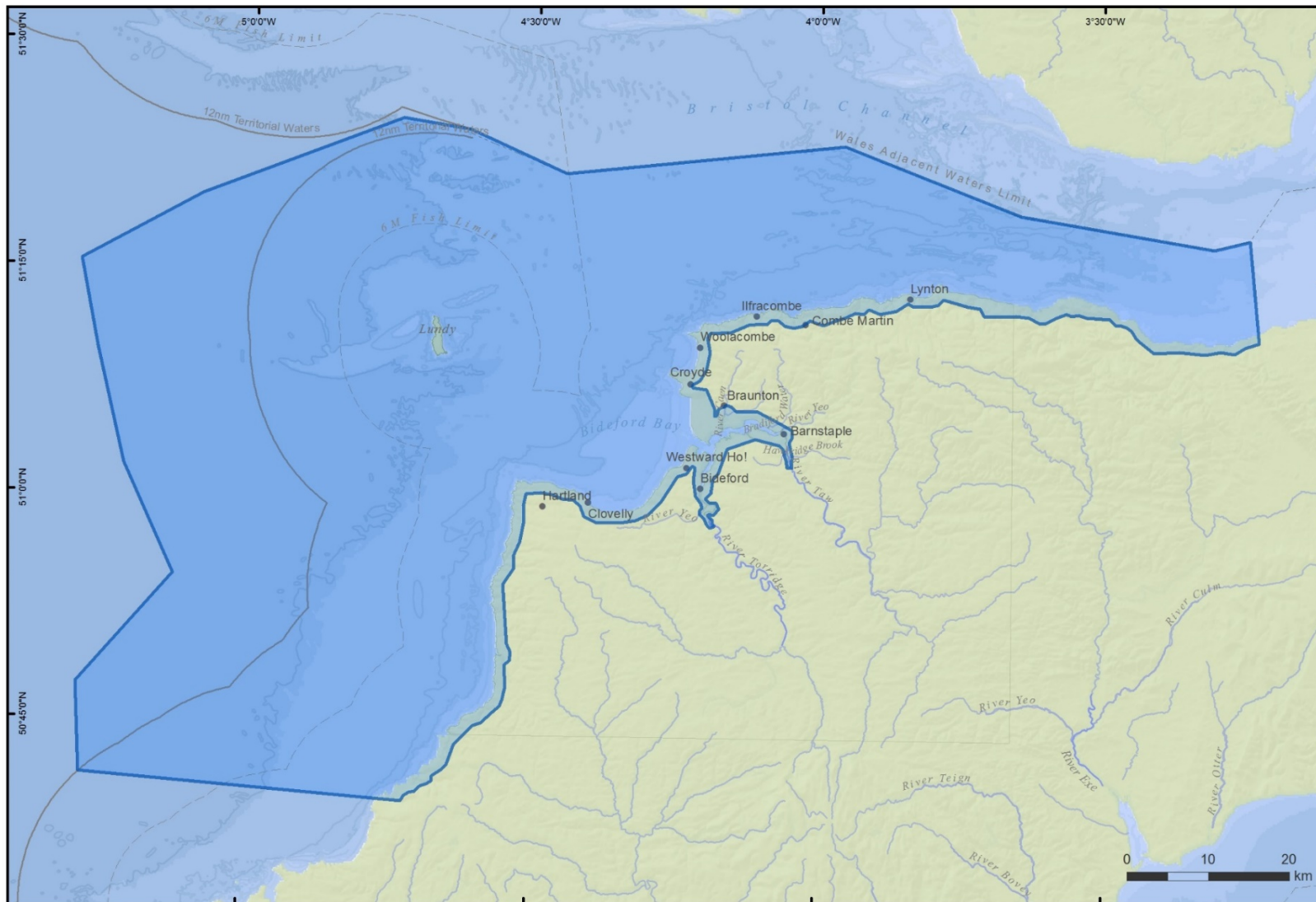
To operationalise the Natural Capital Approach Defra has created four pioneer projects to inform the development and implementation of the 25 Year Environment Plan. The Marine Pioneers are located in North Devon and Suffolk. The North Devon Marine Pioneer (NDMP) is intended to test, at a local scale, how marine natural capital can be effectively managed to deliver benefits to the environment, economy and people, and identify how best to share and scale up this learning.

The purpose of the report is to develop the framework for the application of the Natural Capital Approach in the marine environment, building on a knowledge base from the NERC SWEEP project that will specifically support the delivery of the Pioneer programme in North Devon and associated projects including the WWF led UK SEAS programme sustainable finance work stream. The project objectives are to: 1) To demonstrate the pathways between ecology, ecosystem services and benefits that influence the human wellbeing; 2) Identify how stakeholders are linked (directly or indirectly) to natural capital; and 3) Identify relevant indicators, data sources and potential means for valuing ecosystem service benefits (monetary and non-monetary).

The following text is intended to provide a non-technical summary. For further details of the methods and analysis, please refer to the dedicated sections within the report.

The North Devon Marine Pioneer (Report Section 3.1)

The North Devon Marine Pioneer boundary encloses over 5500km² of the outer Bristol Channel and eastern Celtic Sea, extending offshore of the north east Cornwall, north Devon and west Somerset coasts (Figure 1). Offshore, Lundy island lies within NDMP. A major estuary, the Taw Torridge estuary also lies within the NDMP boundary (Figure 1). The region within the NDMP supports marine fisheries and recreation industries (Bell, Le Helloco & Stainthorp, 2015). The beaches and coastal landscape are of importance as a UNESCO biosphere reserve and designated as an Area of Outstanding Natural Beauty (AONB). The natural environment attracts national and international tourists supporting a large tourism and hospitality industry (Bell, Le Helloco & Stainthorp, 2015).



Coordinate System: ETRS 1989 ETRS-TM 3000 Projection: Transverse Mercator Datum: ETRS 1989 Projection: Transverse Mercator
 Datum: ETRS 1989 False Easting: 500,000 False Northing: 0 Central Meridian: -3 Scale Factor: 1 Latitude Of Origin: 0 Units: Meter
 Scale: 1:500,000

Figure 1 The North Devon Marine Pioneer boundary (dark blue)

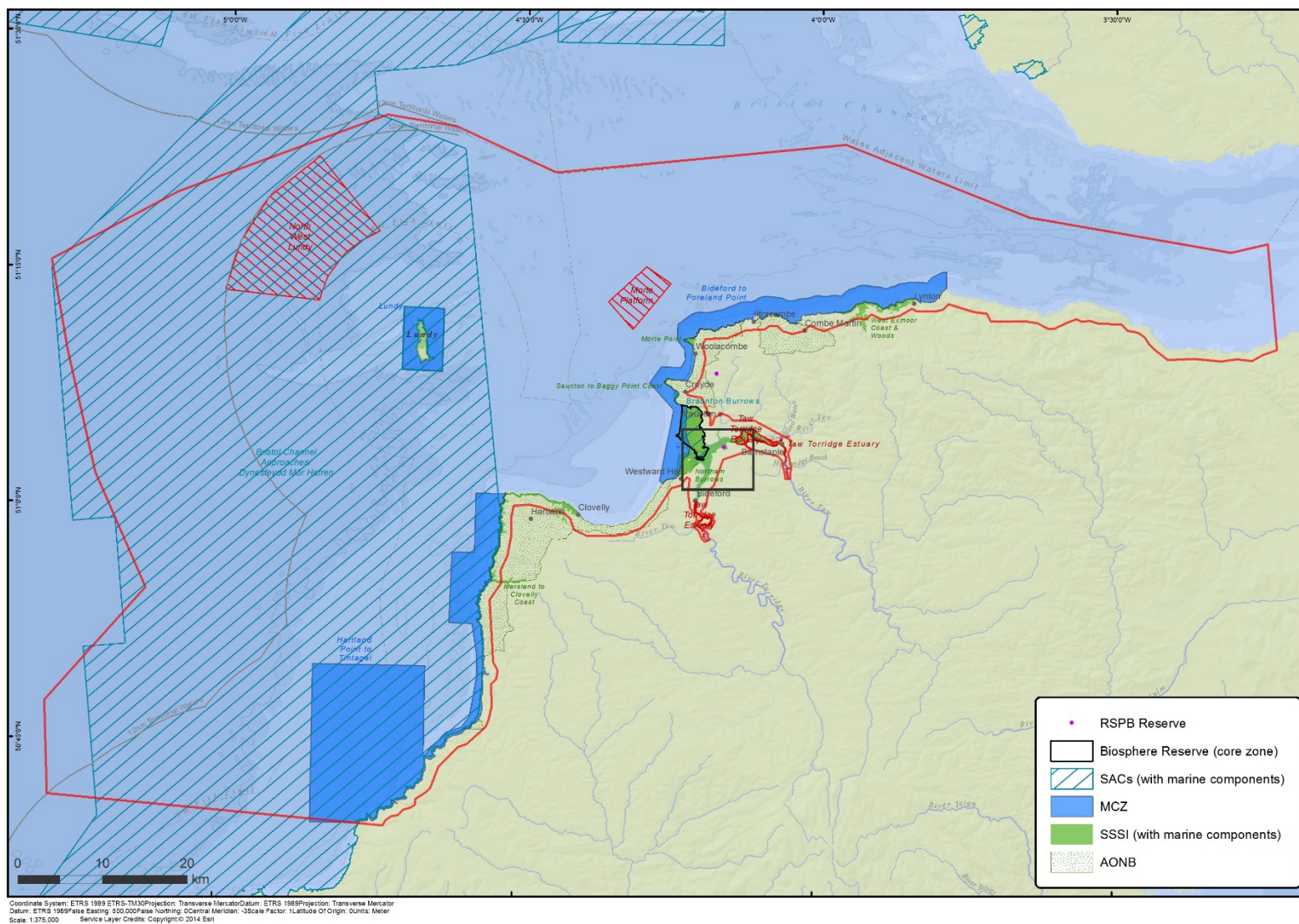


Figure 2 Designated and proposed marine and intertidal conservation sites within NDMP

The Marine Ecosystem Natural Capital Assets in the North Devon Marine Pioneer (Report Section 4.1)

Natural capital is a broad term that can comprise of different parts of an ecosystem, including both living and non-living components along with the ecological processes and functions that support life and livelihoods. Natural capital assets are those parts of the ecosystem that have the capacity to produce goods and services. The natural capital assets in the North Devon Marine Pioneer comprise of the marine habitats, species and the water column.

Academic effort to date has focussed on the spatial extent of marine habitats and species to define natural capital assets and the hence the flows of goods and services (food, recreation). Within this report we do not ignore the water column as an asset, indeed further on in this analysis, we consider the role of the water quality in supporting the physical, economic and social benefits derived from marine ecosystems. Through a focus on marine habitats and species in this first stage as the key marine assets it is recognised that, the ecological processes and functions within the water column (along with exchange to the air and terrestrial environment) support the delivery of many of these goods and services.

To this end, a starting point to determine the natural capital assets in the North Devon Marine Pioneer required the construction of a map to determine the extent of marine and intertidal habitats using best available data (Report Section 4.1) (Figure 3). The data to construct the map were accessed from two sources 1) A Natural England internal habitats dataset, compiled from best available survey maps and; 2) Modelled data from the European Marine Observation and Data Network (EMODnet) and EUSeaMap.

The resulting map defines habitats using the European Nature Information System (EUNIS) habitat classification. EUNIS is a common European system to enable the harmonised description and collection of data across Europe using criteria for habitat identification. The EUNIS habitat classification is a comprehensive pan-European system to facilitate the harmonised description and collection of data across Europe through the use of criteria for habitat identification. It is hierarchical and covers all types of habitat from natural to artificial, from terrestrial to freshwater and marine. EUNIS habitat data is scaled on hierarchy, from 1 to 6 where EUNIS level 1 represents very broad habitat types e.g. sand. The habitat descriptions become more detailed and refined as the EUNIS scale increases. The map for the north Devon Pioneer is presented with marine habitats defined at a minimum of EUNIS level 2/3. There are two key points to note before reviewing the NDMP habitat map:

1. The map is based on “best available evidence” at the time of constructing this report in 2018.
2. There is an associated confidence layer contained within the technical report which demonstrates the uncertainties around the data presented.

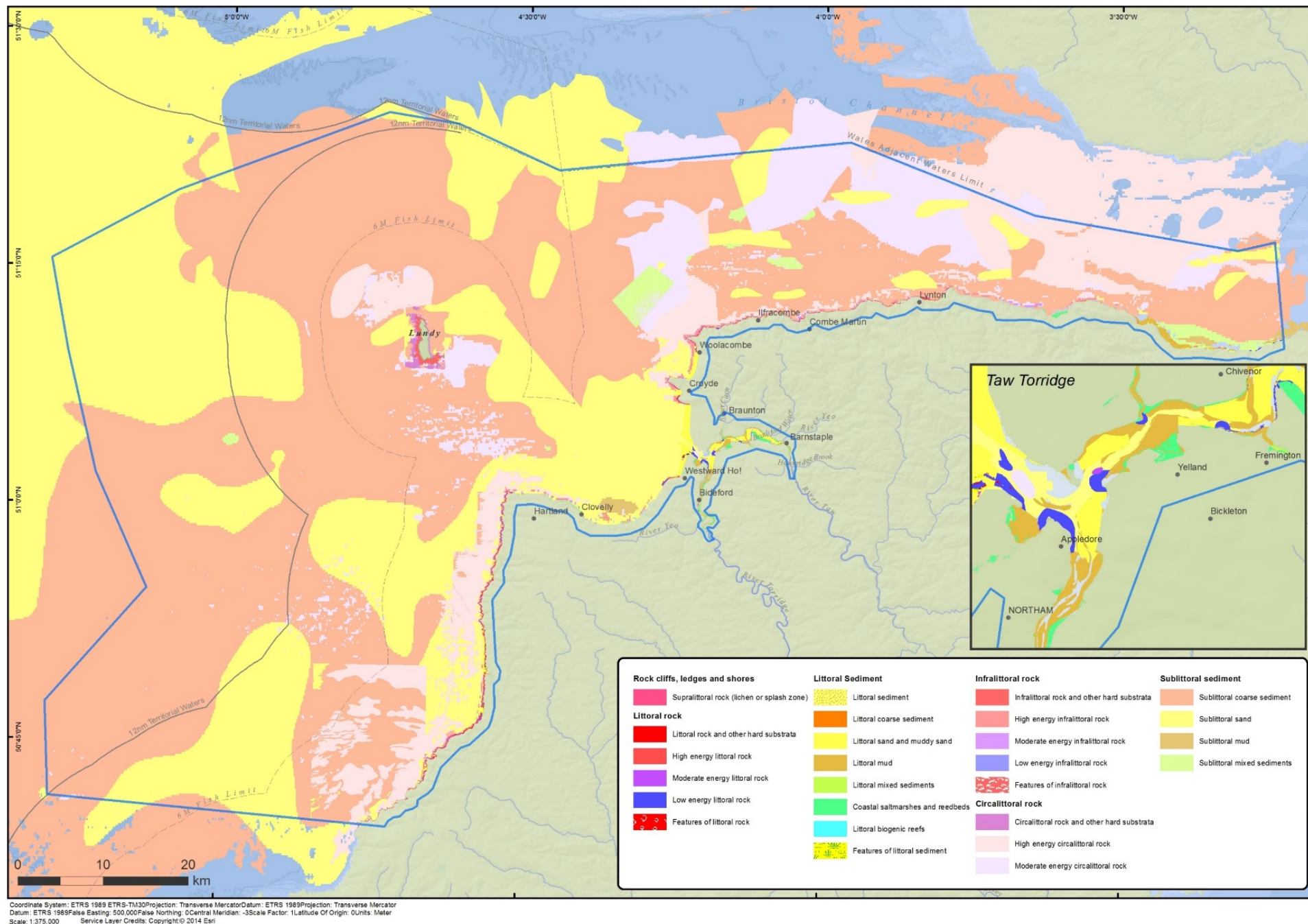


Figure 3 Mapped extent of habitat (Eunis L2/3 or greater) within NDMP

The Flows Ecosystem Services linked to Marine Habitats (Section xx)

To determine how flows of ecosystem services are linked to the processes and functions supported by marine habitats in the NDMP we followed a defined research process that makes use of the most up to date published research literature and expert opinion to link the contribution of each habitat to an ecosystem service (the matrix approach).

Table 1 Habitats providing moderate and/ or significant contribution to multiple ES Goods/Benefits within NDMP

		Goods / Benefits				
		from Provisioning services	from Regulating services			from Cultural services
		Food	Healthy climate	Sea defence	Clean water and sediments	Tourism/nature watching
Natural Capital Asset: Habitats in North Devon Marine Pioneer						
Saltmarsh	Saltmarsh	3	3	3	3	3
Intertidal reef	Littoral (intertidal) rock and other hard substrata	3	2	1		1
Subtidal reef	Infralittoral (shallow) rock and other hard substrata	3	2	1		1
	Circalittoral (deep) rock and other hard substrata	1		1		1
Intertidal sediments	Sand and muddy sand	1	2	3		1
	Mud	3	3	3	3	1
Biogenic reef	Intertidal biogenic reefs	2	1	2	2	1
Subtidal sediment	Coarse sediment	2		3	3	
	Sand	2		3	3	
	Mud	2		3	3	
	Mixed sediments	2		3	3	

Scale of ecosystem service provision relative to other features		Confidence in evidence available to assign ES provision	
#	Significant contribution	3	UK-related, peer-reviewed literature
#	Moderate	2	Grey or overseas literature
#	Low	1	Expert opinion
#	No or negligible		
[Blank]	Not assessed	[Blank]	Not assessed

We found that coastal saltmarsh and intertidal and shallow reefs with seaweed (kelp) communities provide significant contribution to multiple ecosystem services (Table 1). Intertidal biogenic reef and sediment habitats provide important contributions to species habitat, protection of coastal land from flooding and extreme weather (sea defence), and tourism/recreation benefits from beaches.

Subtidal sediments provide an important contribution to food resources for commercial fish species and regulation of clean water (see report section 4.2 for the full review).

For species, in this first stage, the relationship of fish and shellfish species of commercial importance and conservation importance, to the habitats within NDMP, the food resources available and the season they occurred were reviewed. Coastal saltmarsh is important as nursery habitat to bass, herring, cod, sole, plaice and thornback ray. Shallow coastal marine habitats are recognised to be of greatest importance to juvenile fish species. NDMP contains spawning grounds for multiple commercially important species including; cod (winter), sole (spring), plaice (winter), thornback ray (spring and summer), and herring (autumn). Subtidal sediment and circalittoral reef habitats in NDMP provide habitat and specifically food resources for fish species of commercial importance, such as skate and ray species and species of conservation importance such as Common skate (see report section 4.2 for a full review).

Who benefits? (Report Section 5)

Flows of ecosystem services (including goods) support human wellbeing from both a localised context e.g. food, flood protection, opportunities for recreation, and globally e.g. supporting a healthy, habitable climate. In this research we focus on those links to ecosystem services where there local beneficiaries with a direct link to the economic benefit of the ecosystem service. Within this context, we develop a new stakeholder typology illustrative of the range of stakeholders linked to natural capital. To test this typology two key ecosystem services in North Devon that are linked to the local economy were selected 1) Fisheries and aquaculture and; 2) Recreation and tourism.

This review demonstrates that there are wide ranges of stakeholders who can potentially exert influence over natural capital in North Devon. For example in terms of recreation and tourism in the marine environment. The direct beneficiaries of natural capital are individuals who take part in recreation activity (e.g. surfing, kayaking) and businesses who rely on presence and quality of natural assets as the foundation for their business activities. In 2009 the watersports sector in North Devon employed over 2000 staff and generated an estimated 80 million in turnover. In a separate study the North Devon surfing economy was valued at £52.1million per year associated with approximately 42,000 surfers. There are a wide range of governance and supporting stakeholders whose activities facilitate the flow of benefits from natural capital to those direct and indirect stakeholders. These stakeholders either receive funding from central government sources (e.g. Natural England), are charitable organisations (e.g. RNLI) or are private enterprise (e.g. banks). Indirect stakeholders (e.g. tourism associated businesses) also benefit from the expenditure and turnover from the direct stakeholders though they often have no direct association with the resource.

For fisheries, the direct beneficiaries of natural capital are the fishermen who exploit the natural resource for capital gain. In 2016, landings into North Devon ports were valued at £1.5million per year representing a landings weight of 945 tonnes per year. Landings of whelk are the most valuable species with 603 tonnes landed into North Devon ports in 2016 representing £726k in landings value. The majority of the North Devon landings are sold to processors and traders. These sales are not limited to North Devon with traders arranging transport for seafood landed from North Devon ports to the wider market (regional to international). A small amount of catch (fishermen using pots and day boat landings) is sold directly to the consumer market (restaurants). Primary processors located in North Devon will source directly from local landings but the majority of seafood for processing is sourced from outside the region and then sold to national and international markets. Most seafood landed in North Devon is destined for sale outside the region. There are a wide range of governance stakeholders who have influence over Natural Capital linked to fisheries. Financial input is required from central government to fund these organisations to effectively carry out their duties. There are also several influence actors who are linked to natural capital via research, advisory and consultancy and conservation groups.

Traditional approaches to marine management have often focussed on the economic sectors that directly benefit from the natural assets and the governance actors who manage the natural asset and levels of exploitation. This review encourages wider consideration of the indirect and supporting actors who facilitate stakeholder's ability to access the resource and (in some cases) financially benefit from an indirect association with the natural asset. The identification of the wide range of stakeholders linked across the value chain to the natural capital assets supports the process for the identification of shared responsibilities and solutions for the sustainable use.

How is the marine environment managed to retain these benefits? (Report Section 3.2)

As a whole, it is realistic to state that much of the NDMP is subject to management measures in so far that adverse impact to habitats and species is avoided or mitigated through a process that reviews activities in the marine environment (e.g. marine licencing decisions, and risk assessment of operators and activities impact on water quality in water body catchments). Assessments and management measures are aimed at ensuring Good Ecological/Environmental Status is achieved.

In this report we focus on the role of Marine Protected Areas (MPAs) and wider fisheries and SSSI management in protecting marine habitats from physical disturbance. Within the NDMP three types of Marine Protected Area have been designated: Special Areas of Conservation (SAC) under the European Habitats Directive and Marine Conservation Zones (MCZ) and sites of Special Scientific Interest with marine components (SSSI) under the United Kingdom Marine and Coastal Access Act

(MCAA) 2009 (Figure 2). The Marine Management Organisation (MMO) are responsible for the management of MPAs. Between 0-6 miles, Inshore Fisheries and Conservation Authorities (IFCAs) are the lead regulators for fisheries within their Districts and have a duty to further the conservation objectives set for the MPAs. Natural England advise on appropriate management measures for MPAs. The main management measures in place in the NDMP to regulate any physical impacts on marine habitats and species include the setting of bylaws and voluntary measures. Condition assessments of habitat features of MPAs (Natural England) and impact assessments within marine licencing application decision making (MMO and Natural England), ensure activities are monitored and management is introduced to prevent negative impacts on the marine habitats and species. Quality of water inputs into the marine environment are managed through catchment partnerships. Catchments are managed to reduce agricultural pollution, control urban pollution, control chemical pollution and manage waste water, sludge and septic tanks. The regulatory bodies, who apply relevant legislation and policy to regulate and enforce the activities that impact water quality, include central government, Environment Agency, Natural England and Marine Maritime Organisation.

Table 2 Percent of habitats contained in MPAs, extent within MPAs interacting with management measures and extent across NDMP interacting with management measures.

Habitat	Total habitat extent within NDMP (km ²)	% of the habitat extent (within NDMP) contained in an MPA	% of the habitat extent contained in an MPA that also interacts with a benthic management measure (IFCA byelaw)	% of the habitat extent within NDMP that interacts with a benthic management measure (IFCA byelaw)
Saltmarsh (intertidal)	2.80	72	31	22
Littoral (Intertidal) Rock	11.31	92	10	9
Infralittoral Rock	17.27	72	39	28
Circalittoral Rock	875.90	21	5	1
Littoral Sediments	24.97	75	42	34
Littoral Biogenic reef	0.01	100	0	0
Subtidal Sediments	4594.66	5	6	0.3

At the time of writing (April 2018) large proportions (>70%) of littoral (intertidal) and shallow subtidal habitats are contained within conservation designations (SSSIs, MCZs, SACs) (Table 2). Current MPA management measures (IFCA bylaws) focus on protecting species features (spiny lobster) (in Lundy SAC, MCZ and Bideford to Foreland Point MCZ), and reef features in Lundy SAC and MCZ. Bylaws closing areas to use of mobile gears (or requiring operators to apply for licenses for

use of mobile gears) prevent adverse effects on habitats. Management of netting activity protects spiny lobster populations and populations of fish species entering estuaries (e.g. salmon, bass). Recent MCZ assessments, undertaken to identify the impact of fishing practices on MCZ features, will be integral to identifying future management options. SSSI condition assessments are undertaken at least every 6 years by Natural England, and management agreements sought with landowners if features are in unfavourable condition.

Smaller proportions of deeper subtidal (circalittoral) habitats (circalittoral rock and subtidal sediments) are contained within MPA designations (<21% and <5% respectively) and thus, interact with MPA management measures (Table 2). These habitats provide moderate contributions to the ecosystem services of species habitat, food, clean water and sediment and immobilisation of pollution (Table 1). Although interactions with byelaws are limited, voluntary seasonal closures to fishing activity in NDMP do interact with extent of subtidal sediments. Marine licensing decisions also take into account environmental impact to these habitats.

Where are the opportunities? (Report section 4.3)

In this report we propose some potential management responses to protect the natural capital assets (the habitats) that may go further to ensure a long-term flow of ecosystem services. These are, at present, entirely without validation and may provide foundations for discussion.

Coastal saltmarsh and saline reed beds, and intertidal reef and infralittoral rock with tide swept algal communities provide significant contribution to the greatest number of ecosystem services. As hotspots of ecosystem service provision management measures may be considered to manage the majority of the asset.

Outside of the Lundy SAC extents of littoral (intertidal) rock, which are important for sea defence and food provision, are not subject to management measures. Where pressures are identified (enrichment, contamination abrasion) further management may be considered.

The management of littoral (intertidal) sediment interacts with Lundy SAC IFCA bylaws and the Taw Torridge estuary no mobile gear by law. There are opportunities to consider further management of pressures from bait digging, anchoring and mooring, enrichment and contamination from upstream sources.

Shallow subtidal features within Hartland Point to Tintagel MCZ and subtidal sand in Bideford to Foreland Point MCZ have conservation objectives of 'recover'. Identifying management options to restore these habitats to favourable condition will benefit multiple ecosystem services, particularly habitat provision for juvenile and adult fish and shellfish.

Subtidal sediment and circalittoral reef habitats in NDMP provide habitat and specifically food resources for fish species of commercial importance, such as skate and ray species and species of conservation importance such as Common skate. The importance of subtidal sediments to regulating services (clean water and sediments, immobilisation of pollutants benefits) indicates their importance to the broader NDMP ecological system and relationship to water quality and tourism and recreation benefits. Subtidal sediment and reef habitats are designated within Hartland Point to Tintagel MCZ and Bideford to Foreland Point MCZ but only a low percentage of the habitat extent within MPAs currently interacts with management measures to reduce benthic disturbance. It is important to consider the 'recover' objective for these habitats within Hartland Point to Tintagel MCZ and how the flows of ecosystem services can be enhanced through management provisions that will improve the state of the asset.

Across the board where management measures are set to 'maintain' features in a favourable conservation status an objective to 'improve' may be considered in the NDMP to pioneer a 'net gain' approach to marine conservation. A key next step is to review current and future 'risk' to ecosystem service delivery and explore possibilities for more extensive management measures to underpin ecosystem service delivery.

How will we know if marine management is effective?

There is a need to understand changes that are associated with both the demand for ecosystem services and management interventions in order to determine whether management measures are effective or not. Natural Capital Accounting has developed as a method to include the attributes of the physical environment e.g. the marine habitats (assets) and the flows of ecosystem service benefits e.g. recreation (value, employment, health and wellbeing) in an accounting balance sheet. Any gains and losses in the natural capital assets and flows can be monitored in relation to management interventions. The UK National Ecosystem Assessment consider natural capital accounting to be a "foundational activity" which helps to create an appropriate scientific and institutional context within which governments and others can influence decisions affecting ecosystem management across society. The natural environmental features of the NDMP are central to sustainable and resilient blue economy.

In this report we undertake a major review of data that is available for the marine environment and compile that data into a natural capital accounting framework that assigns each of the data sources as an indicator that can be included in a natural capital accounting framework. Indicator metrics and data sources were assigned to categories for 1. Natural Capital Assets (i, extent of natural capital assets, including habitats, species or environmental features and ii, condition or quality of natural

capital assets) 2. Physical benefits related to the ecosystem service (Level of delivery/provision of ES goods/benefits, in relation to the natural capital assets within NDMP, including activities supported). 3. Economic benefits related to the ecosystem service (value and employment associated with the level of delivery of the ES and supported activities). 4. Further social and health benefits (such as unemployment and deprivation levels of communities or level of recreational interaction with nature) were also considered. Indicators were summarised in relation to flow of physical benefits and economic benefits from natural capital assets, relevant to key ES within the framework presented in Table 3.

Table 3 Framework for application of indicator metrics and data sources to assess flow of an ES from Natural Capital resources through to economic and social benefits

Indicators Required to Assess Flow of Ecosystem Services from Natural Capital Assets through to Benefits to Individuals and Communities.							
Physical Accounts					Economic Accounts		
Natural Capital Asset Extent and Condition			Physical ES Benefit		Economic ES Benefit		
Natural Capital Assets (incl. Habitats, Species, Water bodies)	Indicators: extent	Indicators: condition	Level of provision of ecosystem service goods / benefits	Indicators: (identified in ecosystem service literature)	Value	Employment	Health
					Value indicators	Employment indicators Labour market indicators	Physical and mental health indicators

In this report (Section 6.2) we propose indicator data that could populate the natural capital account for the following ecosystem services. 1) Food (wild food – fish and shellfish, including migratory fish); 2) Natural hazard regulation – sea defence (flood prevention); 3) Climate regulation – carbon sequestration (waste burial / removal / neutralisation); 4) Tourism and Recreation (mainland and Lundy), under the following sub categories (Walking and coastal access (including beach use), Diving and snorkelling, Recreational Fishing, Surfing , Boating, kayaking, SUP - coasts and estuaries, Wildlife watching, including tours and Lundy activities) We plan to further refine these indicators with key stakeholders and set baseline accounts for 2017/2018

For example, for food provision (wild food – fish and shellfish, including migratory fish) we propose a framework for data described below.

Table 4 Natural Capital Account tables (asset account, physical benefits account, economic benefits account) including indicators for ES: Food (wild fish and shellfish) within NDMP.

Natural Capital Assets	Indicator		Unit	Baseline year 2017	Baseline Trend 2010-2017
Asset Account: Food (fish and shellfish)					
Marine and Coastal Margin habitats (for each habitat in NDMP)	Extent	Habitat data layers	km²		
	Condition	Natural England condition assessment	maintain-recover		
	Condition	pressure x sensitivity layer	km² interacting with pressure = med + sensitivity		
Species stocks (for each fish and shellfish stock used for food)	Condition	ICES stock assessment (n juvenile)	n, biomass t		
Species stocks (migratory salmon) (for each estuary)	Condition	Env. Agency and Cefas salmon monitoring (n juvenile)	n, biomass t		
Water bodies (for each WFD waterbody in NDMP)	Condition (water body)	Env. Agency. Water quality assessment	poor-good		
	Condition (sample site)	Env. Agency. Water quality assessment	n of incidences per yr above threshold		

Natural Capital: Flow from Assets to Physical Benefits	Indicator	Unit	Baseline year 2017	Baseline Trend 2010-2017
Physical Account: Food (fish and shellfish)				
Species stocks (for each fish and shellfish species used for food)	MMO Fishing Activity data: Landings	t/yr		
	Env. Agency and Cefas salmon monitoring (annual catch nets)	n/yr		
Marine and Coastal Margin habitats	Area of habitat reviewed to provide moderate or significant contribution to ES: Food	km²		

Natural Capital: Flow from Assets to Economic Benefits	Indicator	Unit	Baseline year 2017	Baseline Trend 2010-2017
Monetary Account (Economic and social): Food (fish and shellfish)				
Species stocks (for each fish and shellfish species used for food)	MMO Fishing Activity data: Landings	£/yr		
	Env. Agency and Cefas salmon monitoring (annual catch nets)	£/yr		
Marine and Coastal Margin habitats; Species stocks (all)	Businesses supported	n		
	Business turnover total	£/yr		
	Employment provided	n		

Next Steps

The aim of the Pioneer projects are to inform the development and implementation of the Governments 25 Year Environment Plan. The North Devon Marine Pioneer (NDMP) is intended to test, at a local scale, how marine natural capital can be effectively managed to deliver benefits to the environment, economy and people, and identify how best to share and scale up this learning. Based on this initial review the following “next steps” are recommended to maintain progress towards these aims:

Understanding the extent and condition of natural capital assets

The creation of an up to date habitat map based on ‘best available evidence’ and the translation of MESH confidence scores demonstrates that there remains a lack of confidence in the baseline data that can inform on the ‘extent’ of the habitat natural capital assets. Within MPAs where the extent of features have been assessed by survey and condition assessments undertaken by the statutory agencies, detailed data sources are available on the extent and condition of designated habitat features and species features. Outside of designated sites there is limited confidence in the extent and condition of natural capital assets as the only available data are modelled predictions, or stock assessment surveys designed to provide data on fish stocks.

To reduce the burden of extensive habitat surveys to verify extent of marine habitat and species it is recommended that site-specific habitat surveys are undertaken in ‘contentious areas’ proposed for new management measures. There is an opportunity to develop fisher-science partnerships (commercial and recreational) to verify habitat (and species) data in specific areas.

To improve information on the condition status of habitats a next step is to undertake a ‘sensitivity assessment’, which maps the sensitivity of habitats, to pressures from activities (such as abrasion from bottom towed fishing or anchoring and mooring). A spatial data layer which demonstrates historic pressures from activities and the sensitivity/recoverability of that habitat to physical disturbance can provide a proxy measure for the level of ecosystem service provision from a habitat. Visual tools provide an effective for managers to communicate with stakeholders and prioritise actions for risk management. As such, pressure maps are likely to aid identification of issues and spatial locations where shared responsibility is present and solutions are required for sustainable use.

Establishing baseline natural capital accounts

A full baseline natural capital account at a scale relevant to North Devon that considers the extent and condition of the natural capital assets and the stocks and flows of ecosystem services (jobs, values) is essential. Such evidence will support the identification of actions required to achieve a 'net gain' for biodiversity.

A key next step is to establish a baseline natural capital account for NDMP, to enable an understanding of level of provision of ecosystem services based on the current extent and condition of marine habitats and species. Where possible indicator data can be gathered from established sources. For a more detailed assessment relevant to NDMP primary data collection (e.g. questionnaires) will be required.

Underpinning ecosystem service delivery via management measures

Analysis of the flow of ES from assets within NDMP, showed a high proportion of the extent of habitats that provide a significant contribution to multiple ES (saltmarsh, littoral sediments, tide swept algal communities and infralittoral reef features), are currently contained in MPAs (>70%) within NDMP. Within these MPAs 30-40% of these habitats intact with a management measure to reduce impact on the benthic habitats. Subtidal sediments which are important for the ES of food provision and supporting/regulating services are within voluntary, seasonal fishing activity closures, but only a low percentage (5%) of these habitats interact with management measures to reduce benthic disturbance. A key next step is to review current and future 'risk' to ecosystem service delivery and explore possibilities for more extensive management measures to underpin ES delivery.

Performance management

There is a need to understand changes that are associated with both the demand for ecosystem services and management interventions (e.g. the actions of the Marine Pioneer) in order to determine whether management measures are effective or not in supporting sustainable development and achieving a net gain for biodiversity – performance management.

A range of socio-economic indicators have been proposed within this review which may be useful to evaluate the 'performance' of management interventions and the impact of the NDMP over time.

A key next step is to develop an evaluation framework for the NDMP. Applying an evaluation framework to assess impact (or performance) is the systematic process of assessing the causal effects of a project policy or programme. An evaluation framework provides evidence on if and how an intervention affects (or has an impact upon) variables of interest, allowing statistical or

observational analysis of 'change' that underlies an intervention. Evaluation of ES indicators to determine the "performance" of management interventions (including sustainable finance) within the continually evolving marine and coastal policy context the NDMP is vital to identify learning and good practice to support improved marine management and sustainable development. Such evidence may also provide 'confidence' to investors under the development of opportunities for sustainable finance.

Who benefits?

This review demonstrates that there are wide ranges of stakeholders who can potentially exert influence over natural capital in North Devon. Traditional approaches to marine management have often focussed on the economic sectors that directly benefit from the natural assets and the governance actors who manage the natural asset and levels of exploitation. A key next step is to focus on key segments of the value chain to link those 'less addressed' stakeholders more strongly to natural capital. Opportunities for future change may be explored through a process to establish a hierarchy of stakeholders' impact/proximity and influence/power on natural capital to facilitate actions towards shared responsibilities and solutions for sustainable use.